higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

27 MARCH 2018

This marking guideline consists of 8 pages.

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QUESTION 1: PRESSURE

1.1 Given: $P_1 - P_1 = 25\ kPa$

$d = 20\ mm = 0{,}02\ m \rightarrow a = \pi\ x\ 0{,}02^2 = 0{,}0003142\ m^2$ ✓

$D = 160\ mm = 0{,}16 \rightarrow A = \frac{\pi D^2}{4} = \frac{\pi\ x\ 0{,}16^2}{4} = 0{,}02\ m^2$✓

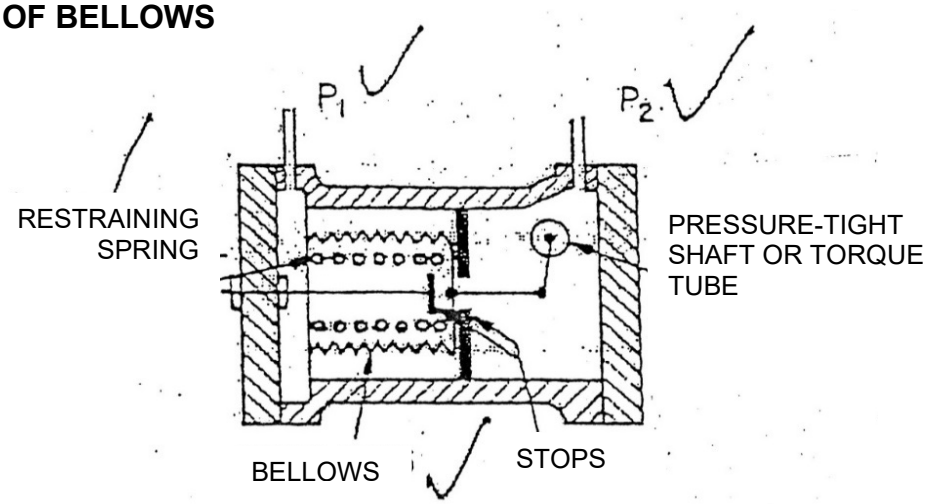
$P_1 - P_1 = p.g.h\ (1 + \frac{a}{A})$✓

$25\ \times\ 10^3 = 13\ 600\ \times\ 10\ X\ h\ \left(1 + \frac{0{,}0003142}{0{,}02}\right)$✓

$h = 0{,}018098\ m = 0{,}18098$

$= 180{,}98$ mm✓ (5)

1.2 **SET OF BELLOWS**



(4)

1.3 $A = 7{,}854\ \times 10^{-7}\ m^2$
$\ell = 50$ m✓
$P = 8\ \times 10^{-7}\ \Omega/m$✓

$R = \frac{\rho\ell}{A}$ ✓

$= \frac{8 \times 10^{-5}\ \times 50}{7\ 854 \times 10^{-7}} = 50902{,}94$

$= 5093{,}946\ k\Omega$✓ (4)

1.4
- Temperature
- Edge thickness
- Length of tube
- Type of material of tube
- Cross-sectional area

(Any 4 × 1) (4)

1.5
- Certain materials can be manufactured that have a high electrical resistance under normal pressure conditions✓ but when the material is compressed, their resistance is drastically reduced.✓
- The change in resistance is proportional to the applied pressure.✓ (3)

1.6
- The application of force onto crystals such as quarts, Rochelle salt and barium titanate generates an EMF proportional to the pressure.
- The ability of some crystals to generate an emf which is proportional to pressure variation. (2)

1.7 Pressure $= \frac{\mathrm{F}}{A} = \frac{M.g}{Area}$✓

$= 180 \times 10^3 \frac{n}{m^2} = \frac{M.10}{0{,}001\ m^2}$✓

$M = \frac{180}{10}$

$= 18\ kg$✓ (3)
[25]

QUESTION 2: LEVEL

2.1 $\frac{h}{2} = 0{,}25\ m$

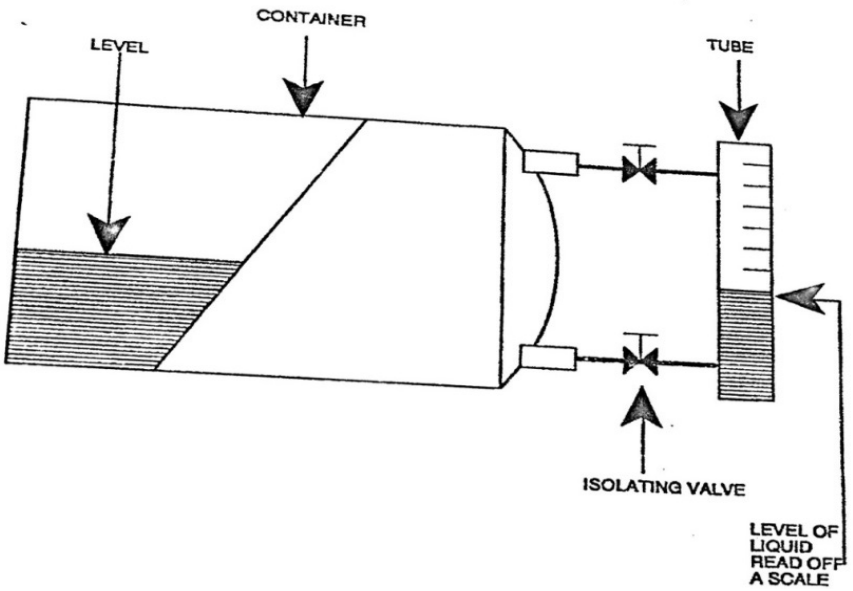
$h = 0{,}25 \times 2 = 0{,}5\ m$

$H_L = \frac{pm}{pL} \times h - L - \frac{h}{2}$

$= \frac{13600}{1000} \times 0{,}5 - 1{,}5 - 0{,}25$

$= 5{,}05$ (4)

2.2 **SIGHT GLASS**



✓✓✓✓

(4)

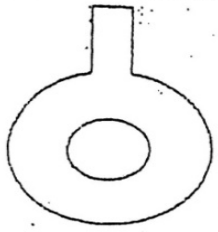
2.3 A dipstick is a rudimentary level-measuring method, but when applied in conjunction with the base dimension of the vessel, a window can be opened into verification of the mass of the vessel especially when checking the measurement and verification of the load cells at calibration. (2)

[10]

QUESTION 3: FLOW

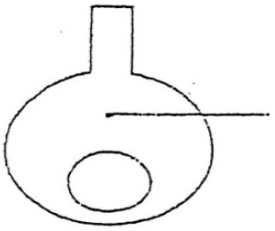
3.1

CONCENTRIC ORIFICE



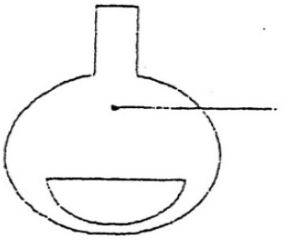
✓
✓

ECCENTRIC ORIFICE



✓
✓

SEGMENTAL ORIFICE



✓
✓

(6)

3.2

$$\frac{Q_2^{\,2}}{Q_1^{\,2}} = \frac{h_2}{h_1}$$

$$\frac{Q_2}{(110)^2} = \frac{180}{100}$$

$$Q_2^{\,2} \times 100 = 2178000$$

$$Q_2^{\,2} = 21780$$

$$Q_2 = 147{,}580\ m^3/hr$$

or

$Given: Q_1 = \frac{110\ m^3}{h}$

$\sqrt{h = 0{,}979}$

$\mathrm{K} = \frac{110\ m^3/h}{\sqrt{0{,}979}}$ ✓

$Q_2 = \mathrm{K}\sqrt{\mathrm{h}}$ ✓

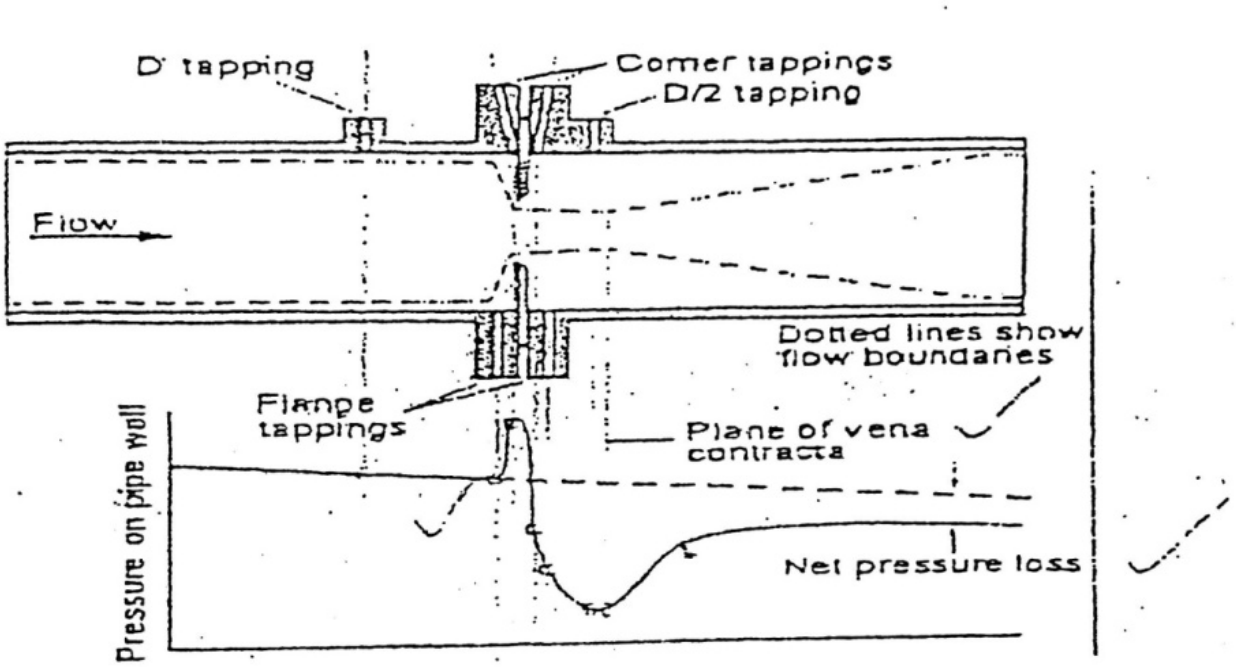
$Q_2 = 111{,}2\sqrt{1{,}7622}$ ✓

$Q_2 = 147{,}62\ m^3/h$ ✓

(4)

3.3 The principle of the measurement involves that as the liquid flows through the meter, it moves a measuring element which seals off the measuring chamber into a series or measuring compartments, each holding a specific volume. These compartments are successively filled and emptied. (3)

3.4 **STATIC PRESSURE PROFILE**



(4)

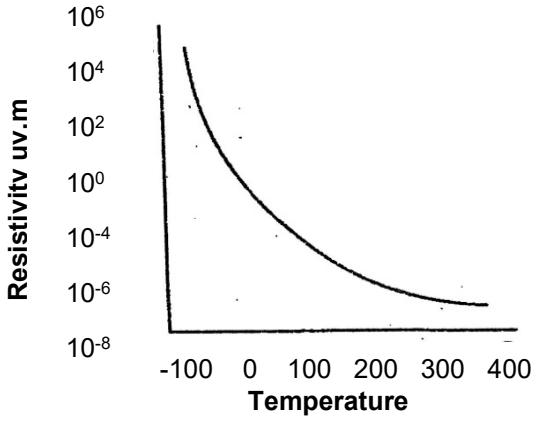
3.5
- Pen and paper
- Square root charts
- Square root mechanism (e.g. square root cam)
- Square root displacer (Any 3 × 1) (3)

[20]

QUESTION 4

4.1 Stefan Boltzmann stated that the rate at which energy is radiated per unit area from a blackbody is proportional to the fourth power of the absolute temperature of the body. (2)

4.2 **CHARACTERISTIC CURVE OF A THERMISTOR**



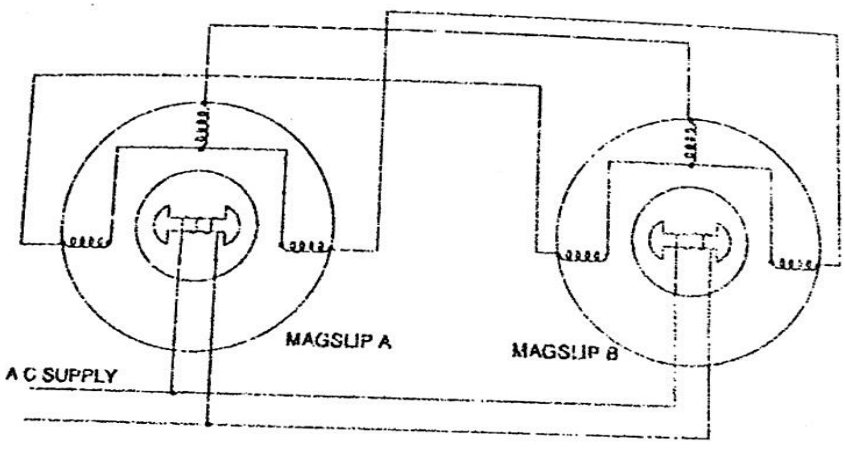
(2)

4.3
- Used as current suppressors. As a surge current limiter.
- Temperature alarms. As a sensitive resistance thermometer for temperature measurements. (2)

4.4
- Provides a great volume of air
- Higher speed (increased response time)
- Pressure amplifier
- To increase the power or energy gain. (Any 2 × 1) (2)

4.5 When two metals are formed and current is made to flow over the junction, the heat will be given off if the current travels in one direction and absorbed when it travels in the opposite direction. (2)

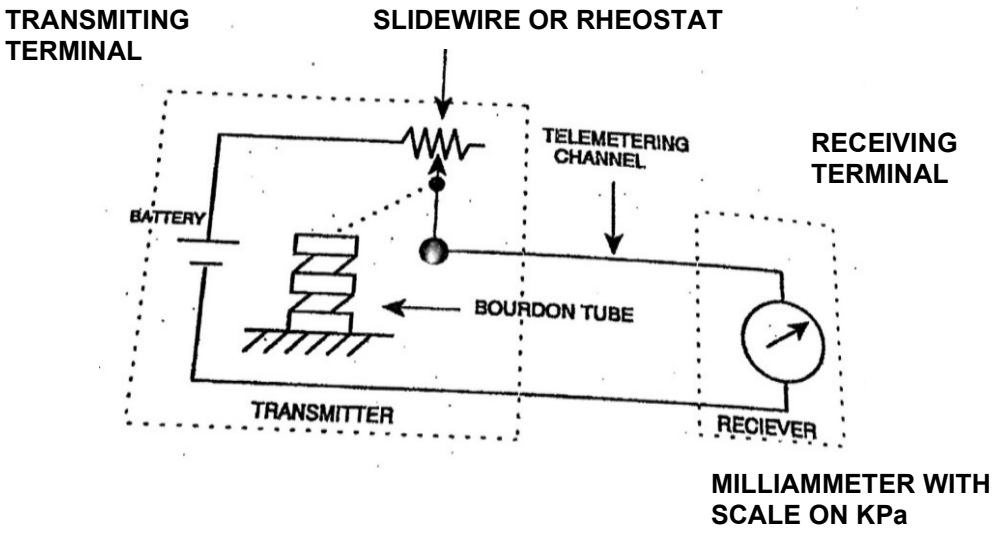
4.6 **MAGSLIP TELEMETERING SYSTEM**



(4)

4.7 The filament of the electric lamp is located in the common focal plane of the objective lamp.
The intensity of the electric bulb is varied by the rheostat and the current flowing through the lamp is measured by the milliampmeter.
The operation of the instrument consist in first focusing the eyepiece on the filament of the light bulb and then pointing the telescope at the heated object and adjusting the brightness of the bulb by means of the resistance until the filament disappears from view. (5)

4.8 Basic current telemetering system

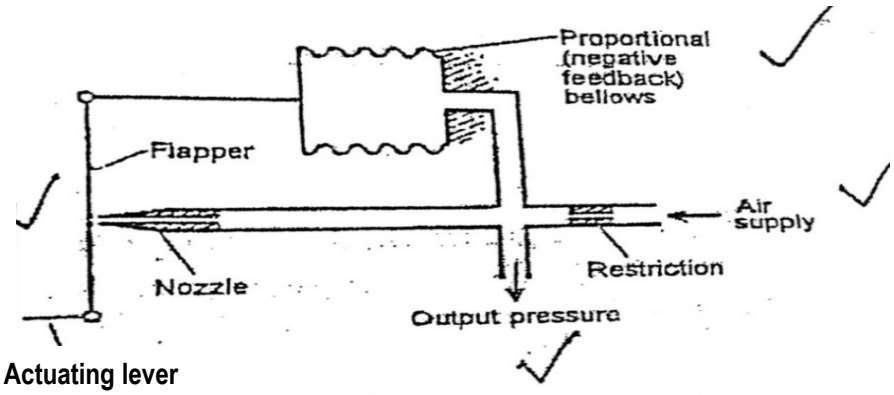


(4)
[23]

QUESTION 5

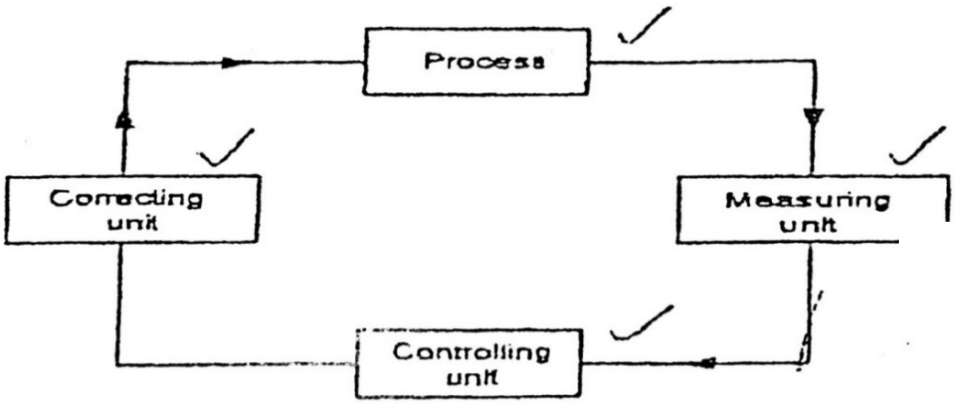
5.1 It is a control action where the corrections (output signal) is proportional (but opposite) to the deviation from the set point. (2)

5.2 **FLAPPER AND NOZZLE SYSTEM**



(4)

5.3 **CLOSED-LOOP CONTROL SYSTEM**



(4)

5.4
- Is a device attached to a valve actuator which moves the actuator stem in accordance with the value of the input signal.
- A valve positioner is a device that is installed between the actuator and the controller. It moves the actuator stem in accordance with the value of the input signal. (2)

5.5 The measured variable is the function to be controlled, for example the flow temperature level or pressure. (2)

5.6
1. Measuring element/connecting linkage
2. Flapper
3. Pivot
4. Negative feedback bellows
5. Restriction
6. Input signal or Air supply
7. Output pressure
8. Nozzle (8 × 1) (8)

[22]

TOTAL: 100

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